

# **Why Was Japan Left Behind in the ICT Revolution?**

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**Prepared for the Fourth World KLEMS Conference**

**May 23-24, the BBVA Foundation, Madrid**

# 1. Motivation

Comparison of the sources of labor productivity growth in Japan and the United States after 1990 shows that Japan's labor productivity growth was lower than that of the US because of Japan's slow ICT capital deepening and lower TFP growth. (Jorgenson, Nomura, and Samuels 2015 report similar results for the period 1991-2012.) On the other hand, non-ICT capital deepening and labor quality improvements were swifter in Japan than the US.

**Japan-US Comparison of Sources of Labor Productivity Growth (annual rate, %)**

	Japan: 1990-2010	US: 1990-2007
Labor productivity growth	1.8	2.4
Contribution of ICT capital deepening	0.4	0.8
Contribution of non-ICT capital deepening	0.5	0.3
Contribution of labor quality improvement	0.5	0.3
Contribution of TFP growth	0.4	1.1

Sources: JIP Database 2014 and EU KLEMS ISIC Rev. 3, March 2011 Update.

# 1. Motivation (Contd.)

ICT-capital deepening in Japan was much slower than in the US in all sectors. **The slower ICT-capital deepening in distribution and total manufacturing, excluding electrical machinery, probably is an especially serious problem.** The reason is that these are ICT-intensive sectors and the main engine of the ICT revolution in the US. In the US, the TFP growth rates of these sectors accelerated from the mid-1990s.

## Japan-US Comparison of Contribution of ICT-Capital Deepening to Labor Productivity Growth by Sector (annual rate, %)

	Japan: 1990-2010	US: 1990-2007
ICT goods and services	1.0	1.7
Total manufacturing, excluding electrical	0.4	0.6
Production of other goods	0.1	0.3
Distribution	0.2	0.7
Finance and business, excluding real estate	0.9	1.4
Personal services	0.1	0.2
Market economy	0.4	0.8

Sources: JIP Database 2014 and EU KLEMS ISIC Rev. 3, March 2011 Update.

# 1. Motivation (Contd.)

In distribution and total manufacturing, excluding electrical machinery, TFP growth in the US after 1990 was much higher than in Japan.

**Japan-US Comparison of TFP Growth by Sector (annual rate, %)**

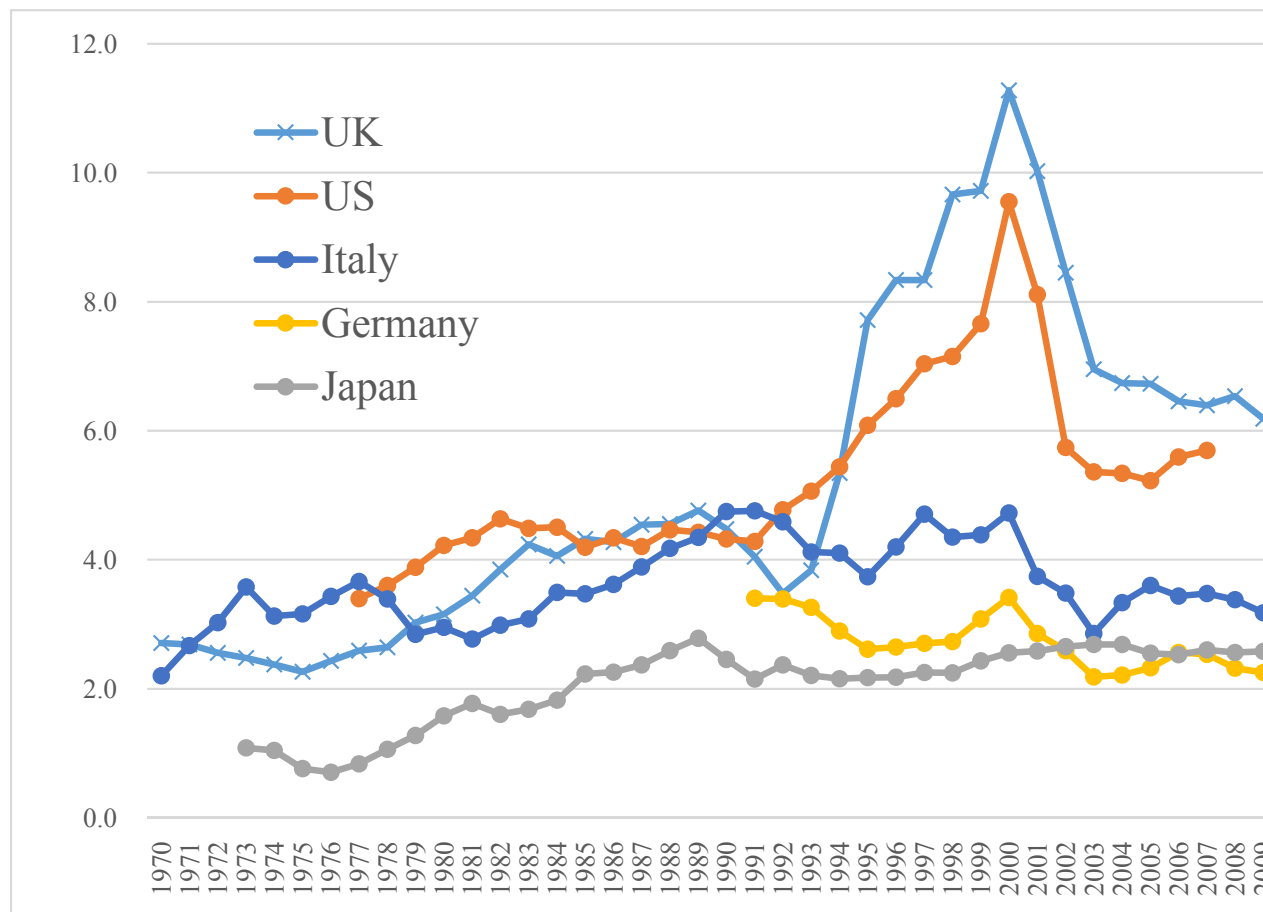
	Japan: 1990-2010	US: 1990-2007	Each sector's labor input share in the total market economy in Japan (1990-2010 average, %)
ICT goods and services	6.4	6.5	5.0
Total manufacturing, excluding electrical	0.3	1.1	21.0
Production of other goods	-1.2	-1.1	18.8
Distribution	0.7	2.4	25.8
Finance and business, excluding real estate	-0.3	-0.4	13.9
Personal services	-0.6	0.5	15.6
Market economy	0.4	1.1	100.0

Sources: JIP Database 2014 and EU KLEMS ISIC Rev. 3, March 2011 Update.

# 1. Motivation (Contd.)

It appears that the ICT revolution did not happen in Japan simply because Japan has not accumulated sufficient ICT capital (Inklaar, Timmer, and van Ark 2006, Fukao 2013).

**ICT Investment-Gross Value Added Ratio in Major Developed Economies: Distribution Services**



Source: EU KLEMS Database, Rolling Updates.

# 1. Motivation (Contd.)

Using firm-level data of two METI surveys,

- *The Basic Survey of Japanese Business Structure and Activities* (Basic Survey)
- *The Actual Conditions Survey of Information Technology* (IT Survey)

we examine what factors impede ICT input in Japan.

We focus on firm size and firm age, since small firms and older firms play a greater role in Japan's economy than in other economies and preceding studies have shown that

- Adoption of ICT increases with the size of the firms: Pilat (2004)
- Larger plants are more likely to employ new technologies: Dunne (1994), Luque (2000)
- Younger plants are more likely to adopt ICT: Dunne (1994), Luque (2000)

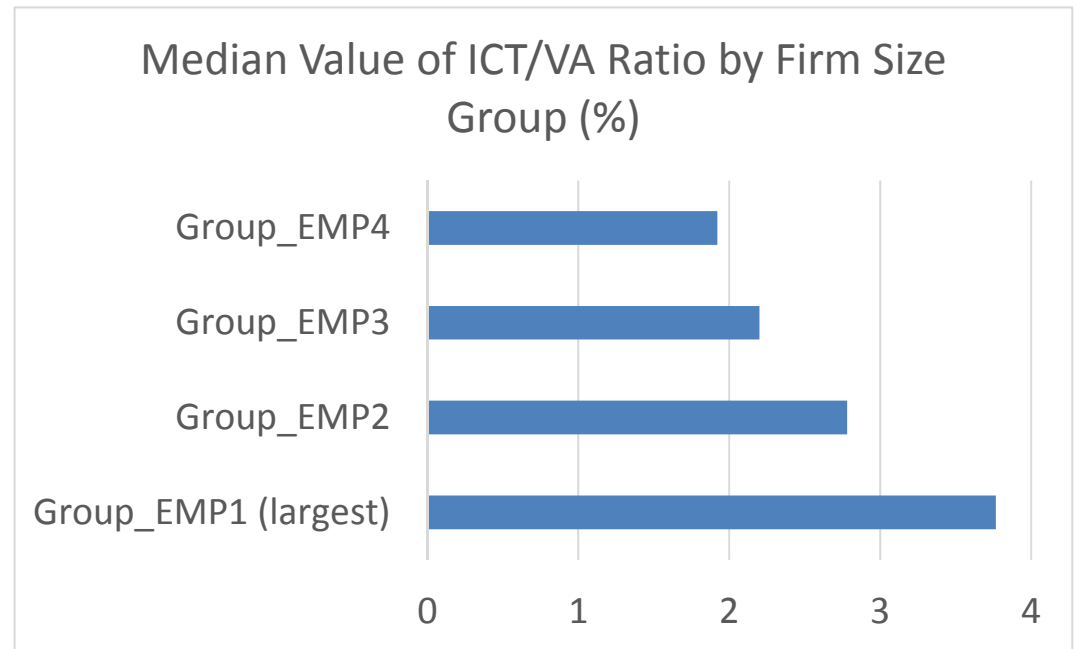
## Structure of Presentation

2. Are Smaller and Older Firms Less ICT Intensive?
3. Do Production Functions and the Marginal Product of ICT Differ by Firm Size and Firm Age?
4. What Impedes the Full Use of ICT by Japanese Firms?

## 2. Are Smaller and Older Firms Less ICT Intensive?

Yes, smaller firms are less ICT-intensive.

They tend to spend less on ICT software and ICT services.



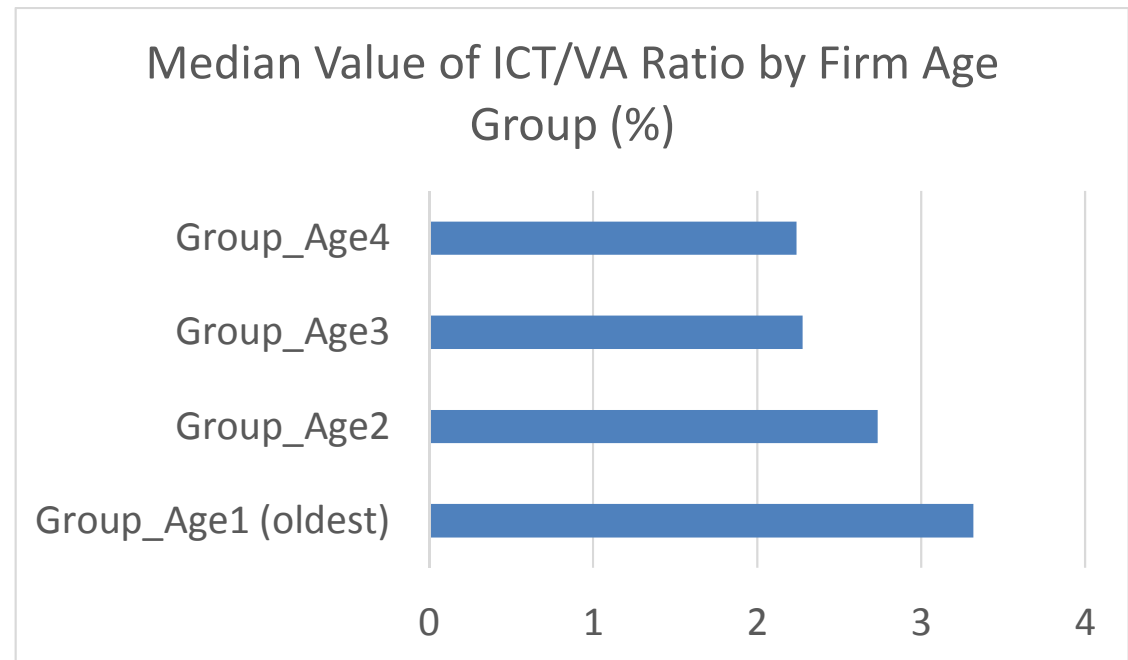
**Table 4(a). Composition of ICT Expenditures by Firm Size**

Group	ICT hardware/Total ICT expenditure (%)	ICT software/Total ICT expenditure (%)	ICT service input/Total ICT expenditure (%)	Other ICT expenditure/Total ICT expenditure (%)
Group_EMP1 (largest)	15.4	41.7	27.6	15.4
Group_EMP2	15.4	32.1	20.3	32.3
Group_EMP3	16.4	20.5	19.4	43.7
Group_EMP4	15.9	29.6	20.6	33.9
<b>Total</b>	<b>15.8</b>	<b>31.1</b>	<b>22.0</b>	<b>31.2</b>

(Other ICT expenditure includes the labor costs of the information system division, communication line fees, fees for usage of data centers, etc. )

## 2. Are Smaller and Older Firms Less ICT Intensive? (Contd.)

No, younger firms are less ICT-intensive.





### 3. Do Production Functions and the Marginal Product of ICT Differ by Firm Size and Firm Age?

By estimating production functions, we can check whether the low ICT intensity of smaller (younger) firms is caused by the adoption of less ICT intensive technology or by constraints on ICT input, such as liquidity constraints or high ICT input cost.

$$\begin{aligned}\ln Y_{f,t} &= \lambda_0 + \alpha \ln(L_{f,t}) + \beta \ln(K_{f,t}) + \gamma \ln(ICT_{f,t}) \\ &+ \sum_{\theta} \alpha_{\theta} x_{\theta,f,t} \ln(L_{f,t}) + \sum_{\theta} \beta_{\theta} x_{\theta,f,t} \ln(K_{f,t}) + \sum_{\theta} \gamma_{\theta} x_{\theta,f,t} \ln(ICT_{f,t}) \\ &+ \sum_{\theta} \delta_{\theta} x_{\theta,f,t} + \varepsilon_{f,t}\end{aligned}$$

$$\frac{\partial Y_{f,t}}{\partial IT_{f,t}} = \frac{\left( \gamma + \sum_{\theta} \gamma_{\theta} x_{\theta,f,t} \right)}{\left( \frac{IT_{f,t}}{Y_{f,t}} \right)}$$

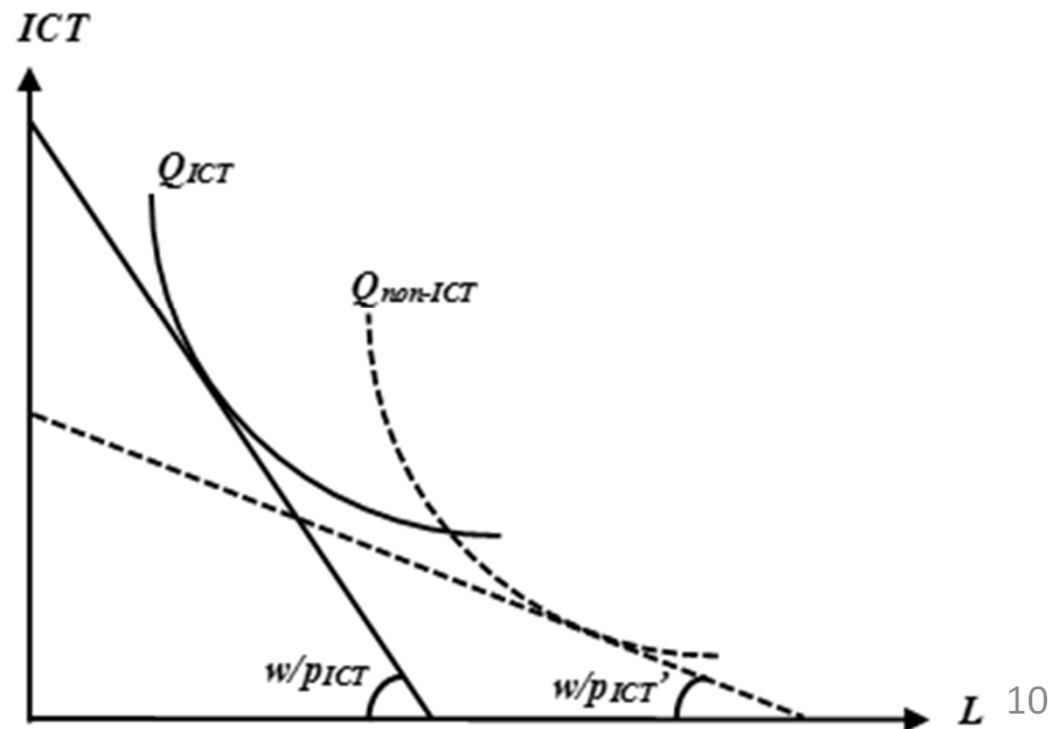
### 3. Do Production Functions and the Marginal Product of ICT Differ by Firm Size and Firm Age?

Main results on firm size:

- Smaller firms tend to have a lower ICT input coefficient.
- However, they tend to have a higher marginal product of ICT input.

How can we explain the finding that smaller firms appear to adopt less ICT-intensive production technologies? The simplest and most plausible answer probably is that the factor prices firms face differ by firm size.

Price of ICT Inputs and the Choice of Technology



### 3. Do Production Functions and the Marginal Product of ICT Differ by Firm Size and Firm Age?

Main results on firm age:

- Younger firms tend to have a higher ICT input coefficient (older firms probably chose their technology in a non-ICT age; younger firms have younger employees (Meyer 2011), etc.);
- Moreover, they tend to have a higher marginal product of ICT input.

We can probably conclude that younger firms cannot raise their ICT input to the optimal level because of some constraints.

Most Japanese banks still require tangible assets as collateral for lending and venture capital markets are not well developed in Japan, so that it is difficult for small/young firms to finance intangible ICT investment such as purchases of ICT software or a reorganization of their information system.

## 4. What Impedes the Full Use of ICT by Japanese Firms?

1. In Japan, the market for business process outsourcing (BPO), which includes outsourcing of ICT processes, is not well developed (METI 2014). Access to efficient vendors of ICT services is a key factor for smaller and younger firms' procurement of ICT input at a reasonable price. Moreover, because of the life-time employment system, ICT experts in Japan tend to prefer working in large firms (NISTEP 1993). These two factors make ICT input more expensive for smaller firms.

Group	Number of employees	ICT input / VA (%)
	Median	Median
Group_EMP1 (largest)	1,783	3.8
Group_EMP2	472	2.8
Group_EMP3	201	2.2
Group_EMP4	89	1.9
Total	307	2.6

Source: Fukao, Ikeuchi, Kim, and Kwon (2015).

The underdevelopment of the BPO market in Japan is closely related with the rigidity of the labor market. Since it is difficult for Japanese firms to lay off workers, Japanese firms hesitate to restructure costly internal business process divisions. Moreover, even when they restructure such divisions, they often relocate workers in such divisions to affiliates or firms in the same business group and procure business process services from the firms to which they transferred former employees. Because of these constraints, Japanese firms cannot procure business services from the most productive vendors, reducing the benefit of BPO and keeping the BPO market underdeveloped (Fukao, Ikeuchi, Kim, and Kwon 2015).

## 4. What Impedes the Full Use of ICT by Japanese Firms? (contd.)

2. The supply of ICT software experts in Japan is much smaller than that in the United States (Arora, Branstetter, and Drev 2011).
3. The scarcity of ICT software experts and the less developed market for outsourcing of ICT processes likely make ICT input prices in Japan more expensive for smaller than for larger firms. Moreover, such small firms are much more prevalent in Japan than in the United States in most sectors.

	All industries				Retail			
	Japan		United States		Japan		United States	
Firm size (No. of employees)	2006		2006		2006		2006	
(a) 1 to 4	1,574,110	5%	6,262,490	5%	625,195	11%	1,101,567	4%
(b) 5 to 9	1,993,335	6%	7,274,534	6%	415,987	7%	1,569,985	6%
(c) 10 to 19	2,736,690	9%	8,794,210	7%	628,979	11%	2,064,520	8%
(d) 20 to 49	4,188,269	13%	12,260,057	10%	669,467	12%	2,942,955	12%
(e) 50 to 99	3,166,835	10%	8,868,873	7%	341,953	6%	1,870,352	7%
(f) 100 to 249	4,144,598	13%	10,497,066	9%	422,022	8%	1,638,001	6%
(g) 250 to 499	2,794,966	9%	6,762,233	6%	339,030	6%	929,095	4%
(h) 500 to 999	2,573,958	8%	6,063,319	5%	353,124	6%	794,140	3%
(i) 1000+	8,935,484	28%	52,125,133	44%	1,780,906	32%	12,524,996	49%
Total	32,108,245		118,907,915		5,576,663		25,435,611	

(Note) Japan: Establishment and Enterprise Census for 2001 and 2006, USA: Business Dynamics Statistics

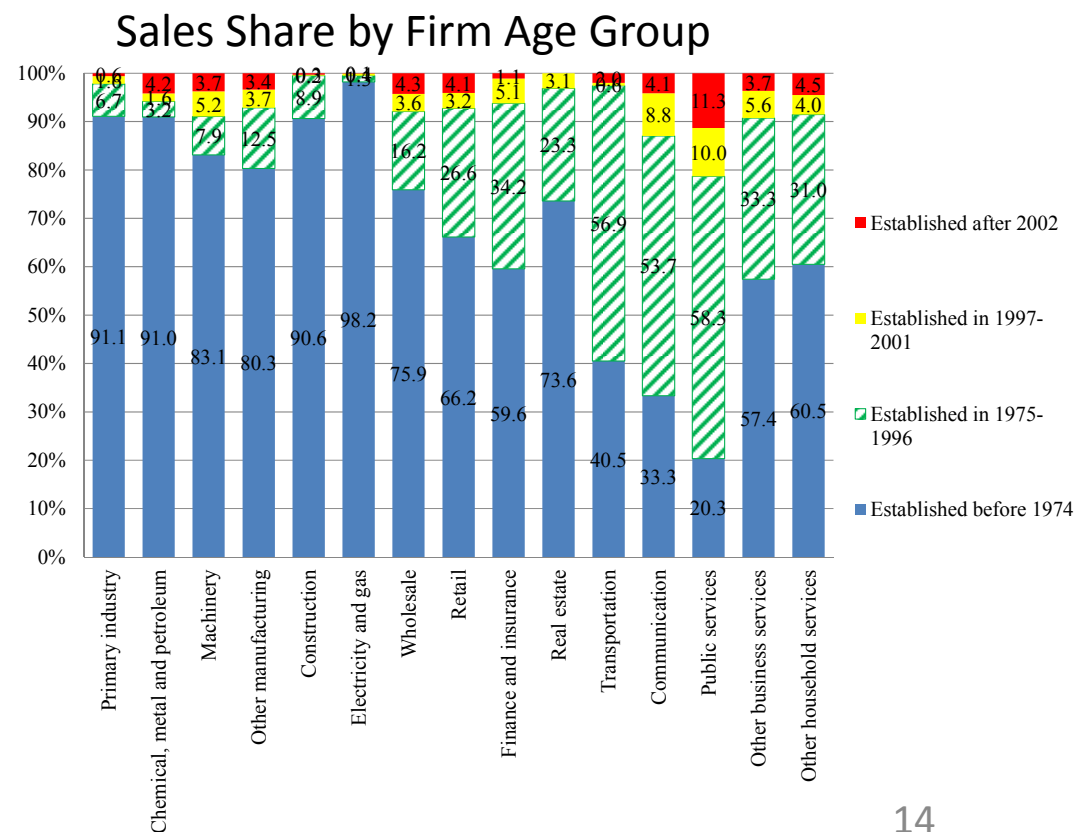
Source: Fukao, Ikeuchi, Kim, and Kwon (2015).

## 4. What Impedes the Full Use of ICT by Japanese Firms? (contd.)

Many important structural impediments to ICT investment in Japan can be pointed out:

1. One of the main contributions of the introduction of ICT is that it allows firms to save unskilled labor input. However, because of the high job security in Japan, it may be difficult for firms to actually cut jobs.

2. Young and growing firms tend to be more active in ICT investment. However, because of the low entry and exit rates in Japan, firms that have been around for 40 years or more have a majority of the market share in most industries.



## 4. What Impedes the Full Use of ICT by Japanese Firms? (contd.)

3. In addition, ICT input prices in Japan are higher than in the United States.

### Japan-US ICT Service Price Comparison for 2012

	Relative price: Japan/US
Telephone call (within city)	1.62
Telephone call (400 km)	3.56
Minimum charge for telephone line (business use)	0.99
Telephone call (international )	9.54
High-speed digital leased line	4.05
International leased line	7.94
Minimum charge for ADSL internet connection	1.09
Cellular phone call charge (one minute)	3.56
Cellular phone monthly fee (packaged plan)	2.92
Packaged software (average cost to purchase 100 sets of Windows Vista, Word 2007, and Excel 2007)	2.27
Outsourcing of payroll accounting	2.56

Source: Fukao, Ikeuchi, Kim, and Kwon (2015). The original data are from METI, *Survey on Foreign and Domestic Price Differentials for Industrial Intermediate Input 2012*.